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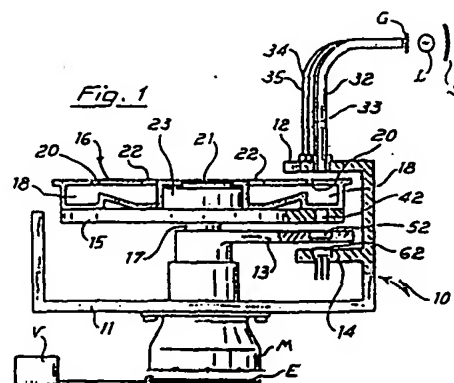
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(54) Analytical photometer, of centrifugal type, for the practically simultaneous determination of the presence of different substances in a certain number of discrete samples.

(57) Analytical photometer for the practically simultaneous determination of the presence of different substances in a certain number of discrete samples. The photometer (10) is equipped with a centrifugal type rotor (16), already known in the art, containing a large number of chambers with inlet holes (20, 22) for the sample/samples and reagents and with axially aligned transparent windows, thereby forming a system of rotating cuvettes (18). The rotor compartments (16) serve as receptacles for the solutions and are designed and dimensioned as already known in the art, such as to retain the liquid when said rotor (16) is at rest and to transfer said liquid into the cuvettes (18) when the rotor (16) rotates. A single or multiple light source (L) is provided, which is transmitted in a novel manner through a system of suitable means, in particular, optical fibres (30-35) to various photodetector units (60 to 65), suitably aligned with the transparent windows of the cuvettes (18) by means of the same number of interference filters (50 to 55) and appropriate holes (40 to 45) situated in the base (15) of the rotor (16). Thus it is possible to determine for the first time, concentrations of chemical solutions through the absorbance in the sample/samples plus reagent/reagents contained in the cuvettes (18) at various wave lengths, with wave energy being delivered from source (L).

Hence it is possible to examine more than one cuvette (18) almost simultaneously and singly, each one for a different analytical parameter, and consequently to examine the transmittance and/or absorbance of the samples contained in the cuvettes at optimum wave length.



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ANALYTICAL PHOTOMETER, OF CENTRIFUGAL TYPE, FOR THE PRACTICALLY SIMULTANEOUS DETERMINATION OF THE PRESENCE OF DIFFERENT SUBSTANCES IN A CERTAIN NUMBER OF DISCRETE SAMPLES

This invention relates to an analytical photometer of centrifugal type for the practically simultaneous determination of the presence of different substances in a certain number of discrete samples.

5

The term 'photometric' as used in the present description should not be considered in the restrictive sense but is broadened more generally to mean 'colorimetric' and 'spectrophotometric'.

10

Therefore in accordance with this use, the term 'photometric' is to be interpreted in its widest sense to cover those instruments denoted both as 'colorimetric' and 'spectrophotometric'. The term 'light' as used in this description includes the radiant energy both in the visible spectra and in the invisible spectra, as well as the radiant energy limited to specific wave lengths.

Hence it is interpreted as an invention involving systems using different types of radiations to carry out the required measurements.

An obvious gap in the already known centrifugal analyzers is the necessity of preparing the samples for photometric analysis on different parameters, entailing heavy time losses due to restarts or the use of completely separate machines.

5

This situation limits analytical output making it lengthy and time consuming.

The main scope of the invention is to provide a photometric  
10 system capable of carrying out analyses on any number of discrete samples, each one of which requiring a different number of parameters, whereby the whole system is limited only by the number of cuvettes in the rotor. Hence the machine is capable of producing one or more diagnostic profiles on  
15 one or more patients. Moreover, it is also possible to carry out by-chromatic and poly-chromatic analyses.

These main scopes and others of lesser importance will appear clear after a careful examination of the detailed description which follows, together with the accompanying drawings.  
20

Subject of the invention is - as already mentioned in the preamble - a photometer for the practically simultaneous determination of the presence of different substances in a  
25 certain number of discrete samples each one of which may - or may not - require parameters differing from the others.

The invention employs a large number of sample-holding cuvettes with axially aligned cuvettes arranged within a centrifugal rotor.  
30

The USA Patent 4.226.531 talks about a disposable type plastic rotor, but nothing is mentioned in this patent regarding the nature and path of the rays outside the rotor. In this patent, as also in the preceding USA Patent No. 3.555.284  
5 mention is made of a photometer equipped with rotor containing a series of cuvettes. However, these patents describe solutions by which the presence of one single substance can be determined in all the samples only in succession. More exactly, in the USA Patent 3.555.284, a single light source  
10 and a photodetector apparatus are aligned each single time with the various windows for determining the concentrations of the chemical solutions.

The progress achieved with the photometer described in this  
15 invention, as compared with the solutions already known in the art, is therefore quite appreciable.

In fact, also in the photometer described in the invention, the solution-holding compartments are designed and dimensioned  
20 ed to retain the liquid when the rotor is stationary and to transfer said liquid to the cuvettes when the rotor is rotating.

The novelty of the photometer in accordance with the invention  
25 ion consists in the fact that the light source - which can be single or multiple - provided in said photometer can be transmitted simultaneously through a system of suitable means, preferable optical fibres, or else prisms or mirrors, to various photodetector units, aligned with the windows, in order  
30 er to determine the concentration of the chemical solutions through the absorbance of the light, in the sample/samples mixed with specific reagents, contained in the cuvettes, at

different wave lengths. The output data of the photodetector unit is indicate the phototransmittance of the samples contained in each cuvette. Therefore, with the photometer described in the invention it is possible for the first time  
5 to analyze practically simultaneously a certain number of samples and each sample for any required number of parameters, the only limitation being the number of cuvettes in the rotor.

10 The accompanying drawings, taking into account that this is only a general example, illustrate a preferred embodiment of the photometer in accordance with the invention. In these drawings:

fig. 1 is a diametral section and partial view of the base  
15 comprising the turntable incorporating various cuvettes, while fig. 2 is a plan view of fig. 1 with certain parts removed.

Fig. 3 is similar to fig. 1 but illustrates the turn table detached from its base;

20 lastly fig. 4 is a development of section IV-IV of fig. 2.

As can be seen from the drawing, the analytical photometer in accordance with the invention and denoted as a whole in the figure by the number 10, essentially comprises a fixed  
25 base 11, supported by a motor M and a revolving rotor 16 with members 15, 17, of which member 15 serves a support for said rotor 16 while the other member 17 is an integral part of member 15 and of the shaft of motor M.

30 Th optical fibres 30 to 35 (six as in the figure or more) are connected through suitable jointing to memb r 12 on ba-

The light source L (just one in the drawing) provided between a mirror or screen S and an athermic filter G, is transmitted to said optical fibres 30 to 36.

- 5 The rotor 16, which the art is essentially acquainted with, incorporates forty or more cuvettes 18, arranged radially side-by-side.

Upper holes 22 and 20, drilled above each cuvette 18, serve  
10 for dispensing the liquid into each of these cuvettes, or rather the discrete sample and the necessary chemical reagent optimized for a specific wave length.

Naturally, the samples are mixed with the reagents by cen-  
15 trifugal force when rotor 16 starts rotating steadily.

The holes (40 to 45 in fig. 4) drilled in base 15 are the same number as the cuvettes 18. Upon rotation, they are made to coincide one at a time with one of the optical fibres (30  
20 to 35 in the figure) or with the other equivalent means provided for transmission of the light beam L. Therefore, this light beam is transmitted (as shown in the figure by optical fibres) through the various chemical solutions one at a time contained in the same number of cuvettes 18. Then it passes  
25 through holes 40 to 45 and interference filters 50 to 55, thereby reaching the same number of photodetectors 60 to 65, aligned with the transparent windows of above mentioned cuvettes 18, and said photodetectors being capable of determining the absorbance in the discrete samples contained in  
30 said cuvettes 18, at a specific wave length. The electrical signals generated by photodetectors 60 to 65 are sent to a processor V.

An optical decoder E (sketched in the figure with a rectangle) is likewise appropriately provided. Said decoder supplies an electrical synchronizing signal for each reading position of cuvette 18 to said processor V.

5

As the optical fibres 30 to 35 used and therefore the simultaneously analyzed chemical solutions contained in the cuvettes as well as the relative photodetectors 60 to 65 used are six in number (as in the figure) or even more, it can be seen that the photometer 10 in accordance with the invention represents a very great step forward in its own particular industrial field, as already mentioned earlier on.

By way of completion, in figures 1 and 4 of the drawings, the numbers 21 and 23 denote two overlapping members integral with base plate 15 of rotor 16, said members being exactly seated in the central recess 25 and in the one below it, said recesses being incorporated in rotor 16, so as to render said rotor integral and rotatable with its base 15.

20

13 and 14 denote instead the sectors to which are applied interference filters 50 to 55 and photodetectors 60 to 65 respectively.

25 Lastly, in fig. 2 the number 21' denotes an upper retaining wall for member 23 supporting rotor 16.

As any person skilled in the art can easily deduce, numerous variations may be effected, without departing from the true scope of the invention, to the analytical photometer hitherto disclosed and illustrated, as already stated - according to a preferred embodiment of the invention, taking into ac-

count that this is only a general example.

It has already been stated that the suitable means for simultaneously transmitting the light beam at multiple points  
5 need not only be of optical fibres, but may be of mirrors, prisms or other equivalent means.

It goes without saying that their number as well as that of the interference filters and of the photodetectors can be  
10 higher or lower than that illustrated, and likewise, variations may be made to the number of cuvettes included in the rotor, to their sectional shape and moreover to that of the windows for addition of the discrete samples and reagents respectively in said cuvettes.

## CLAIMS

1) Analytical photometer of centrifugal type consisting of  
and  
5 characterized by a fixed support (11) - supported by a motor  
(M) - and by a rotor (16) containing various transparent  
cuvettes (18), already known in the art, said rotor being  
integral and rotatable with a support plate (15) and with the  
end (17) of the shaft of said motor (M); within said fixed  
10 support (11) suitably shaped protrusions are provided, capa-  
ble of supporting, from top to bottom: the first, supporting  
various means (30 to 35) for transmitting a single or multi-  
ple light source (L) simultaneously on to various transpa-  
rent windows of the same number of axially aligned cuvettes  
15 (18) containing one or more discrete samples and respective  
specific reagents, previously mixed together by centrifugal  
force; the second, supporting various interference filters  
(50 to 55) and lastly the third, supporting various photo-  
detectors (60 to 65); the entire system being designed so  
20 that it is possible to measure almost instantaneously through  
a processor (V) the concentration of various chemical solu-  
tions through the absorbance or the transmittance in the  
sample or samples contained in various cuvettes (18) at dif-  
ferent wave lengths, and therefore to obtain the results of  
25 one or more diagnostic profiles on one or more patients.

2) Analytical photometer of centrifugal type as claimed in  
claim 1,  
characterized in that said photometer comprises a revolving  
30 rotor (16), preferably of plastic, already being known in the  
art, but with said rotor incorporating up to forty or more  
cuvettes (18) divided into external chambers of rectangular

section in which can be added from the top various reagents through the upper holes (20) preferably circular in shape, and various internal chambers practically triangular in shape in which can be added from the top one or more discrete samples for analysis through the upper holes (22) preferably rectangular in shape; sufficient space being left between the internal and external chambers to permit the samples to be shifted periferically by centrifugal force to the reagents and be mixed with them, or vice versa.

10

3) Analytical photometer of centrifugal type as claimed in claims 1 and 2, characterized in that the revolving support (15) of rotor (16) is provided along its edge with as many holes (40 to 45 in fig. 4) as there are cuvettes (18).

15

4) Analytical photometer of centrifugal type as claimed in claims 1 to 3, characterized in that said photometer also comprises an optical decoder (E) for supplying an electrical synchronizing signal for each reading position of the cuvettes (18) and for transmitting said signal to a processor (V).

20

5) Analytical photometer of centrifugal type as claimed in claims 1 to 4, where the single or multiple light source (L), incorporated in said photometer is situated between a mirror (S) and an athermic filter (G).

25

6) Analytical photometer of centrifugal type as claimed in claims 1 to 5, characterized in that the means (30 to 35) for transmitting

30

a single light source (L) simultaneously to various transparent windows of the same number of axially aligned cuvettes (18) consist of optical fibres, prisms or mirrors.

5 7) Analytical photometer of centrifugal type as herein disclosed and illustrated in the accompanying drawings.

8) Analytical photometer of centrifugal type as claimed in claims 1 to 7 representing a colorimeter.

10

9) Analytical photometer of centrifugal type as claimed in claims 1 to 7 representing a spectrophotometer.

10) Analytical photometer of centrifugal type as claimed in  
15 claims 1 to 9 in which the light used contains as much radiant energy in the visible spectra, as in the invisible spectra.

11) Analytical photometer of centrifugal type as claimed in  
20 claims 1 to 10,  
in which the radiant energy used and transmitted through the optical fibres or other equivalent means to photodetectors is radiant energy limited to specific wave lengths.

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Fig. 1

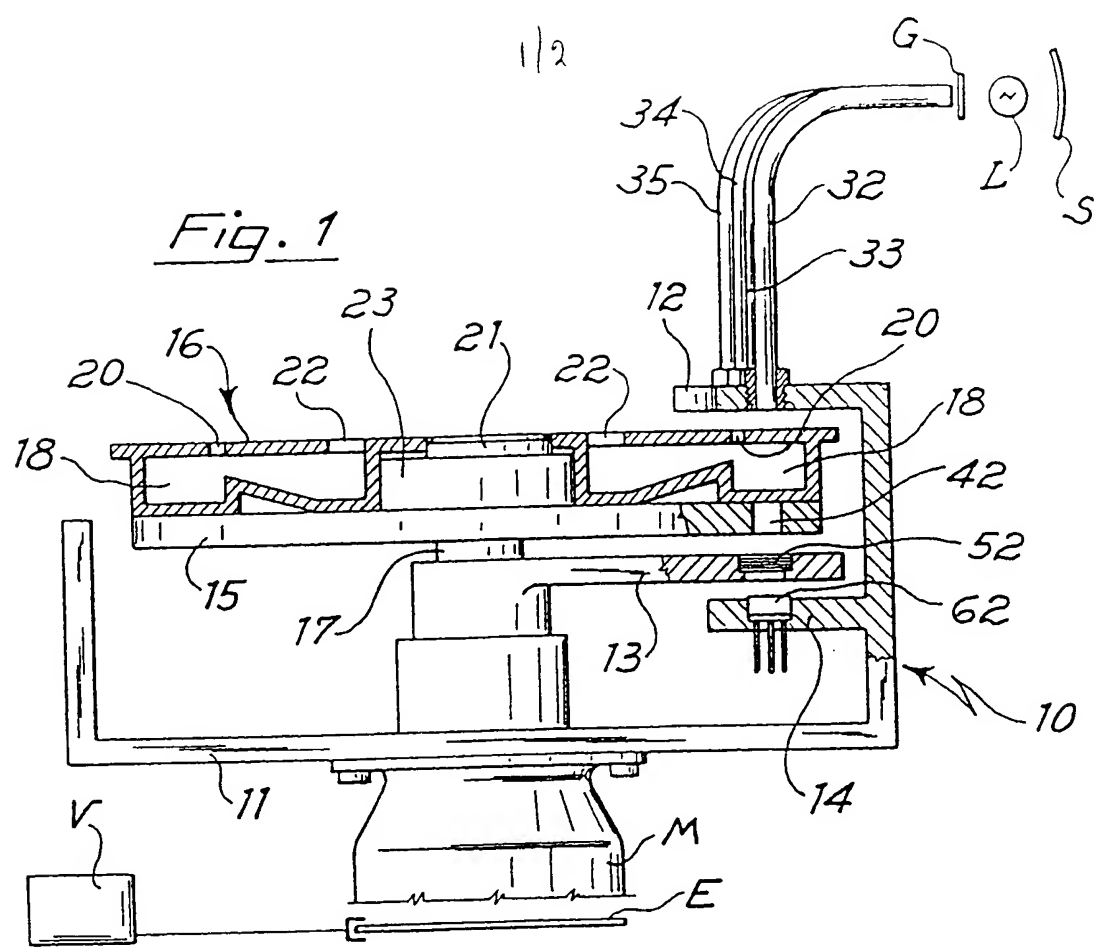


Fig. 2

